

IN THE SPECIFICATION:

Please amend the specification as follows:

Page 1, just below the title, please insert the following:

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority to European Application 02256792.9, filed September 30, 2002, the entire contents of which are incorporated herein by reference.

Page 1, please amend paragraph [0002] as follows:

2. Description of the Related Art

[0002] The term “patterning device” as here employed should be broadly interpreted as referring to device that can be used to endow an incoming radiation beam with a patterned cross-section, corresponding to a pattern that is to be created in a target portion of the substrate. The term “light valve” can also be used in this context. Generally, the pattern will correspond to a particular functional layer in a device being created in the target portion, such as an integrated circuit or other device (see below). An example of such a patterning device is a mask. The concept of a mask is well known in lithography, and it includes mask types such as binary, alternating phase-shift, and attenuated phase-shift, as well as various hybrid mask types. Placement of such a mask in the radiation beam causes selective transmission (in the case of a transmissive mask) or reflection (in the case of a reflective mask) of the radiation impinging on the mask, according to the pattern on the mask. In the case of a mask, the support ~~structure~~ will generally be a mask table, which ensures that the mask can be held at a desired position in the incoming radiation beam, and that it can be moved relative to the beam if so desired.

Page 1, please amend paragraph [0003] as follows:

[0003] Another example of a patterning device is a programmable mirror array. One example of such an array is a matrix-addressable surface having a viscoelastic control layer and a reflective surface. The basic principle behind such an apparatus is that, for example, addressed areas of the reflective surface reflect incident light as diffracted light, whereas

unaddressed areas reflect incident light as undiffracted light. Using an appropriate filter, the undiffracted light can be filtered out of the reflected beam, leaving only the diffracted light behind. In this manner, the beam becomes patterned according to the addressing pattern of the matrix-addressable surface. An alternative embodiment of a programmable mirror array employs a matrix arrangement of tiny mirrors, each of which can be individually tilted about an axis by applying a suitable localized electric field, or by employing piezoelectric actuators. Once again, the mirrors are matrix-addressable, such that addressed mirrors will reflect an incoming radiation beam in a different direction to unaddressed mirrors. In this manner, the reflected beam is patterned according to the addressing pattern of the matrix-addressable mirrors. The required matrix addressing can be performed using suitable electronics. In both of the situations described hereabove, the patterning device can comprise one or more programmable mirror arrays. More information on mirror arrays as here referred to can be seen, for example, from U.S. Patents 5,296,891 and 5,523,193, and WO 98/38597 and WO 98/33096. In the case of a programmable mirror array, the support ~~structure~~ may be embodied as a frame or table, for example, which may be fixed or movable as required.

Page 2, please amend paragraph [0004] as follows:

[0004] Another example of a patterning device is a programmable LCD array. An example of such a construction is given in U. S. Patent 5,229,872. As above, the support ~~structure~~ in this case may be embodied as a frame or table, for example, which may be fixed or movable as required.

Page 2, please amend paragraph [0006] as follows:

[0006] Lithographic projection apparatus can be used, for example, in the manufacture of integrated circuits (ICs). In such a case, the patterning device may generate a circuit pattern corresponding to an individual layer of the IC, and this pattern can be imaged onto a target portion (e.g. comprising one or more dies) on a substrate (silicon wafer) that has been coated with a layer of radiation-sensitive material (resist). In general, a single wafer will contain a whole network of adjacent target portions that are successively irradiated via the projection system, one at a time. In current apparatus, employing patterning by a mask on a mask table, a distinction can be made between two different types of machine. In one type of

lithographic projection apparatus, each target portion is irradiated by exposing the entire mask pattern onto the target portion at once. Such an apparatus is commonly referred to as a wafer stepper. In an alternative apparatus, commonly referred to as a step-and-scan apparatus, each target portion is irradiated by progressively scanning the mask pattern under the ~~projection~~ beam in a given reference direction (the "scanning" direction) while synchronously scanning the substrate table parallel or anti-parallel to this direction. Since, in general, the projection system will have a magnification factor  $M$  (generally  $< 1$ ), the speed  $V$  at which the substrate table is scanned will be a factor  $M$  times that at which the mask table is scanned. More information with regard to lithographic devices as here described can be seen, for example, from U.S. Patent 6,046,792.

Page 3, please amend paragraph [0008] as follows:

[0008] For the sake of simplicity, the projection system may hereinafter be referred to as the "lens." However, this term should be broadly interpreted as encompassing various types of projection system, including refractive optics, reflective optics, and catadioptric systems, for example. The radiation system may also include components operating according to any of these design types for directing, shaping or controlling the ~~projection~~ beam of radiation, and such components may also be referred to below, collectively or singularly, as a "lens". Further, the lithographic apparatus may be of a type having two or more substrate tables (and/or two or more mask tables). In such "multiple stage" devices the additional tables may be used in parallel or preparatory steps may be carried out on one or more tables while one or more other tables are being used for exposures. Dual stage lithographic apparatus are described, for example, in U.S. Patents 5,969,441 and 6,262,796.

Page 4, please amend paragraph [0009] as follows:

[0009] In all of the above-mentioned systems, radiation-induced carbon contamination, causing the formation of films on optical elements, is a considerable problem. Even very thin carbon films can absorb a remarkable amount of the ~~projection~~ beam leading to a reduction in energy throughput in the optical train. Further, these carbon films may be non-homogeneous and as such can result in phase shifts and patterning errors. An effective strategy is therefore required to mitigate the effects of carbon contamination.

Page 4, please amend paragraph [0013] as follows:

[0013] This and other aspects are addressed according to an embodiment of the present invention in a lithographic apparatus including a radiation system configured to supply a ~~projection~~ beam of radiation; a support configured to support a patterning device, the patterning device configured to pattern the ~~projection~~ beam according to a desired pattern; a substrate table configured to hold a substrate; a projection system configured to project the patterned beam onto a target portion of the substrate; and a supply configured to supply to a space in the apparatus a composition including at least one of one or more perhalogenated C<sub>1</sub>-C<sub>6</sub> alkanes; and one or more compounds consisting essentially of one or more nitrogen atoms and one or more atoms selected from hydrogen, oxygen and halogen.

Page 5, please amend paragraph [0015] as follows:

[0015] The composition is supplied to a space in the apparatus, for example into the projection system. Activation of this composition either by applying the ~~projection~~ beam to the space containing the composition, or by use of an alternative activation source, leads to the excitation or dissociation of the compounds into various reactive species. These reactive species act as highly selective etching components, efficiently removing hydrocarbons without causing damage to the surface of any EUV mirrors present. In addition, the compositions used in the present invention typically provide a high etching rate of hydrocarbon species. Their light absorption is also generally low and the introduction of such materials into the optical train therefore has little or no adverse effect on transmissivity.

Page 5, please amend paragraph [0018] as follows:

[0018] According to a further aspect of the present invention there is provided a device manufacturing method including ~~providing a substrate that is at least partially covered by a layer of radiation-sensitive material;~~ providing a ~~projection~~ beam of radiation using a radiation system; using a patterning device to endow the ~~projection~~ beam with a pattern in its cross-section; projecting the patterned beam of radiation onto a target portion of ~~[[the]]~~ a layer of radiation-sensitive material at least partially covering a substrate; supplying to a

space through which the ~~projection~~ beam passes a composition including at least one of one or more perhalogenated C<sub>1</sub>-C<sub>6</sub> alkanes and one or more compounds consisting essentially of one or more nitrogen atoms and one or more atoms selected from hydrogen, oxygen and halogen; and producing reactive species of the composition.

Page 7, please amend paragraph [0029] as follows:

[0029] The source LA (e.g. a discharge or laser-produced plasma source) produces radiation. This radiation is fed into an illumination system (illuminator) IL, either directly or after having traversed a conditioning device, such as a beam expander Ex, for example. The illuminator IL may comprise an adjusting device AM configured to set the outer and/or inner radial extent (commonly referred to as  $\sigma$ -outer and  $\sigma$ -inner, respectively) of the intensity distribution in the ~~projection~~ beam PB. In addition, it will generally comprise various other components, such as an integrator IN and a condenser CO. In this way, the ~~projection~~ beam PB impinging on the mask MA has a desired uniformity and intensity distribution in its cross-section

Page 8, please amend paragraph [0032] as follows:

[0032] The depicted apparatus can be used in two different modes:

1. In step mode, the mask table MT is kept essentially stationary, and an entire mask image is projected at once, i.e. a single “flash,” onto a target portion C. The substrate table WT is then shifted in the X and/or Y directions so that a different target portion C can be irradiated by the beam PB;
2. In scan mode, essentially the same scenario applies, except that a given target portion C is not exposed in a single “flash.” Instead, the mask table MT is movable in a given direction (the so-called “scan direction”, e.g., the Y direction) with a speed  $v$ , so that the ~~projection~~ beam PB is caused to scan over a mask image. Concurrently, the substrate table WT is simultaneously moved in the same or opposite direction at a speed  $V = Mv$ , in which  $M$  is the magnification of the lens PL (typically,  $M = 1/4$  or  $1/5$ ). In this manner, a relatively large target portion C can be exposed, without having to compromise on resolution.

Page 8, please amend paragraph [0033] as follows:

[0033] Figure 2 schematically depicts the projection system of an embodiment of the present invention in more detail. In this embodiment, the space to which the composition is supplied is the projection system PL. In alternative embodiments, the space is typically any area in the apparatus through which the ~~projection~~ beam passes. Preferred spaces are those containing at least a part of the radiation system and/or at least a part of the projection system. Preferably, the space contains at least one mirror.

Page 9, please amend paragraph [0037] as follows:

[0037] After its introduction into the space in the apparatus, the composition is activated by an activation device 6. Typically, activation is carried out at a separate time from, for example prior to, exposing the substrate. The space is then optionally purged or evacuated to remove the composition prior to exposure. Activation can be achieved, for example, by irradiating the space containing the composition with the ~~projection~~ beam. However, alternative activation may be used, provided the activation is capable of dissociating or exciting at least some (and preferably the majority) of the molecules in the composition. Examples of alternative activation are additional UV sources, for example a DUV or EUV source, plasma sources, an electrical or magnetic field or electron irradiation. It is preferred that the activation is by the ~~projection~~ beam itself, in particular when using an EUV ~~projection~~ beam, since this leads to a high degree of dissociation of the compounds in the composition and thus enhanced cleaning efficiency.

Page 10, please amend paragraph [0041] as follows:

[0041] Typically, the composition includes one or more compounds selected from perhalogenated C<sub>1</sub>-C<sub>6</sub> alkanes, nitrogen dioxide, nitrogen oxoacids, nitrogen hydrides and salts of nitrogen hydrides, the salts including nitrogen, hydrogen, oxygen and halogen atoms. For example, the composition may include one or more compounds selected from perhalogenated C<sub>1</sub>-C<sub>6</sub> alkanes, nitrogen oxoacids, nitrogen hydrides and salts of nitrogen hydrides, the salts including nitrogen, hydrogen, oxygen and halogen atoms. In these salts, the halogen is typically fluorine, chlorine or bromine, preferably fluorine. Typically, the perhalogenated C<sub>1</sub>-C<sub>6</sub> alkanes are perfluorinated C<sub>1</sub>-C<sub>6</sub> alkanes. Preferred C<sub>1</sub>-C<sub>6</sub> alkanes are

C<sub>1</sub>-C<sub>4</sub> alkanes, in particular methane and ethane. Thus, preferred perhalogenated C<sub>1</sub>-C<sub>6</sub> alkanes are perfluorinated C<sub>1</sub>-C<sub>4</sub> alkanes, in particular perfluoromethane and perfluoroethane. Typically the nitrogen oxoacid is nitric acid (HNO<sub>3</sub>). The nitrogen hydrides are compounds including only nitrogen and hydrogen atoms. Examples of nitrogen hydrides include ammonia (NH<sub>3</sub>), hydrazine (N<sub>2</sub>H<sub>4</sub>), hydrogen azide (HN<sub>3</sub>), ammonium azide (NH<sub>4</sub>N<sub>3</sub>), hydrazinium azide (N<sub>2</sub>H<sub>5</sub>N<sub>3</sub>), diazene (N<sub>2</sub>H<sub>2</sub>) and tetrazene (H<sub>2</sub>N-N=N-NH<sub>2</sub>). Preferred nitrogen hydrides are ammonia, diazene and hydrazine, in particular ammonia. Typically, the salts of nitrogen hydrides are ammonium salts. Examples of ammonium salts include ammonium hydroxide and ammonium halides such as ammonium fluoride, ammonium chloride and ammonium bromide.